

# Dynamics of changes in milk production and distribution in some european countries

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## 1. INTRODUCTION

In 2004 the world milk production was equal to 606 million tons,  $\frac{1}{4}$  of which came from the European Union countries. The biggest milk producers were India (91.5 million tons) and the United States of America (77.2 million tons). In the European countries milk production is very important and constitutes about 18% of the final production in agriculture.

Quantities of milk produced in the European Union countries are strictly limited and subsidized. In 2004 expenditures on subsidizing animal production in the European Union reached 24.4% of agricultural funds (10.43 billion euro); 18% of which were expenditures on milk and dairy products. In 2004, 25 European Union countries (EU-25) produced 143.3 million tons of milk, new members of the European Union (EU-10) produced 21.8 million tons and finally 15 countries – former („old”) members (EU-15) produced 121.5 million tons. Data presented in table 1 shows that in the last three years (2002-2004) milk production was at the similar level.

In 2004 Poland produced about 11.5 million tons of milk which constituted 2.4% of the world production and almost 10% of production coming from 15 old members (EU-15), more than half of the quantity produced by the new members and about 8% of production from all 25 European Union countries. Milk production in Poland is characterized by a high dispersion and a small scale (see table 2).

The characteristic feature of milk production in Poland is a lower level of yield of marketable produce in comparison to this in the European Union. In Poland the yield is equal to 77% while in 15 countries of the European Union (EU-15) it equals to 95%. The share of wholesale in total milk production in Poland equals to 66% and in the European Union it reaches almost 94%. Moreover, in Poland not more than half of farms producing milk deliver their production to dairies which means about 350 thousands of farms. Milk production per capita in Poland (310 kg) is similar to this achieved in the European Union (about 320 kg per capita), but there are big differences in consumption of dairy products and butter per capita (Eurostat, 2004).

Table 1. Milk production in the European Union (in million tons)

Specification	2002	2003	2004
Total EU-15	121.3	123.6	121.5
Total EU-10	22.0	21.8	21.8
Total EU-25	143.3	145.4	143.3

Source: Eurostat

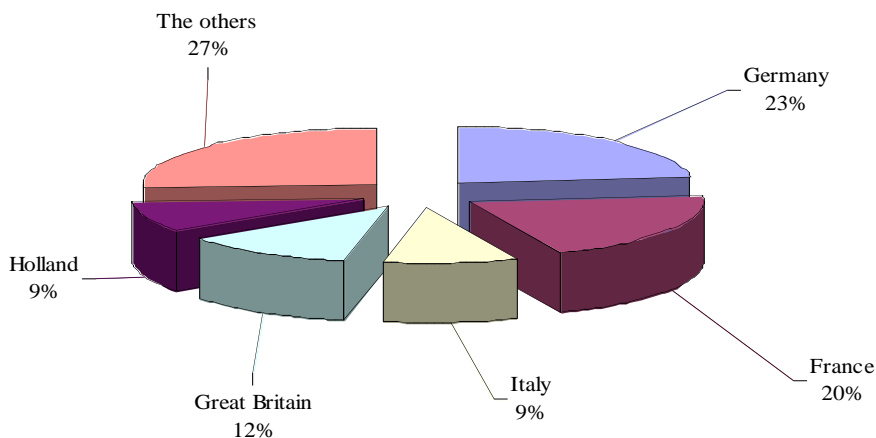
Table 2. Milk production and consumption in Poland and the European Union from 2001 to 2004

Specification	Unit	Poland 2002–2004	EU-15 2001–2004
Total milk production	million tons	11.5	121.5
Milk production per capita	kg	310	320
Share of extra class milk in sale	%	74-92	91-96
Total number of cows	thous. of heads	2967-2780	19545-19258
Number of cows per farm	heads	3.4	34
Shares in cows population of herds including 1-9 cows	%	64	4
10-29 cows	%	26	20
30-99 cows	%	4	56
100 and more	%	6	20
Cows' milking capacity	kg per 1 animal	3902-4120	6129-6404
Yield of marketable milk produce	%	77	95
Share of wholesale in production	%	66	94

Source: Seremak-Bulge (2004)

The biggest milk producers among 15 countries of the European Union (EU-15) are Germany, France, Great Britain, Netherlands and Italy. Those countries produce more than 70% of milk production coming from EU-15 (see diagram 1).

The aim of the paper was to analyze changes in milk production and distribution in the European Union countries from 1970 to 2004. The research focused on five most important milk producers from the group of fifteen European Union countries (EU-15) (see diagram 1) and on Poland which was the biggest milk producer among new members of the EU. The analyses concentrated on changes in time and differences between separate countries referring to the following attributes: milk production level and its yield of marketable produce, volume of milk internal use (animal feeding), export, import and stocks. The researches were based on data for the years 1970-2004 obtained from FAO. We focused on similarities and differences in milk production as well as in milk distribution structures and consumption profiles in Italy and Poland. For the purpose of analyses visualization techniques commonly used in a grade analysis of multidimensional data were employed.



Source: Eurostat 2004, ZPPM

Diagram 1. Shares of the European Union countries in total milk production in 2004

## 2. METHOD

In the research process there were used some tools of grade data analysis (GCCA – grade correspondence cluster analysis). The detailed description of the method is given by Kowalczyk et al., (2004). The method uses the GINI index as a measure of distances between objects and a grade dependence index as a measure of multidimensional data differentiation. The advantage of this method in comparison to the well known methods of cluster analysis (Marida et al., 1979; Aczel, 1993) is a simultaneous presentation of features and objects in a form of an over-representation map. Using a graphic picture one can easily specify features strongest differentiating a division of investigated objects into groups.

The basic issue within the infrastructure of grade data analysis is considering a concentration or in other words a differentiation of one distribution to another one. Let's consider two distributions given on the same set  $\{a_1, \dots, a_k\}$  and let's assume that elements of this set are sorted: (for example  $a_i$  mean considered group of food products,  $p_i$  are shares of products of  $a_i$  group in annual consumption of an average Italian and  $q_i$  are shares of these products in annual consumption of an average Pole). In this case the order of  $a_i$  elements is fixed according to the ratios  $h_i = q_i/p_i$  (see table 3).

Polish and Italian consumption profiles are much different (Borkowski et al., 2004). In the Italian diet the following products are dominant: fruits (twice as high consumption as in Poland), vegetable oils and fish (almost 40% more in comparison to Poland), vegetables, milk and stimulants (almost 15% more in comparison to Poland). Shares of consumed meat, animal fat and eggs were similar in both countries, consumption of potatoes was four times higher in Polish diet. Polish people consume 60% of sugar and honey and 20% of cereals more than Italian. This differentiation may be illustrated by the use of concentration (differentiation) curve describing  $q$ -distribution in relation to  $p$ -distribution. It is a broken line inside of a unit-square

linking the following points:  $(0;0)$ ,  $(p_1;q_1)$ ,  $(p_1+p_2; q_1+q_2)$ , ...,  $(p_1+\dots+p_k; q_1+\dots+q_k) = (1; 1)$ . Slopes of separate segments are given by  $q_i/p_i$  ratios. Generally,  $q_i/p_i$  may be in ascending order, but not only. Figure 1 shows concentration curves for  $q_i/p_i$  ratios in ascending order, so these curves are convex.

A numeric concentration measure is the Gini index given by the formula:

$$ar = 2 \int_0^1 (u - C(u)) du,$$

where  $C$  means a function describing a concentration curve.

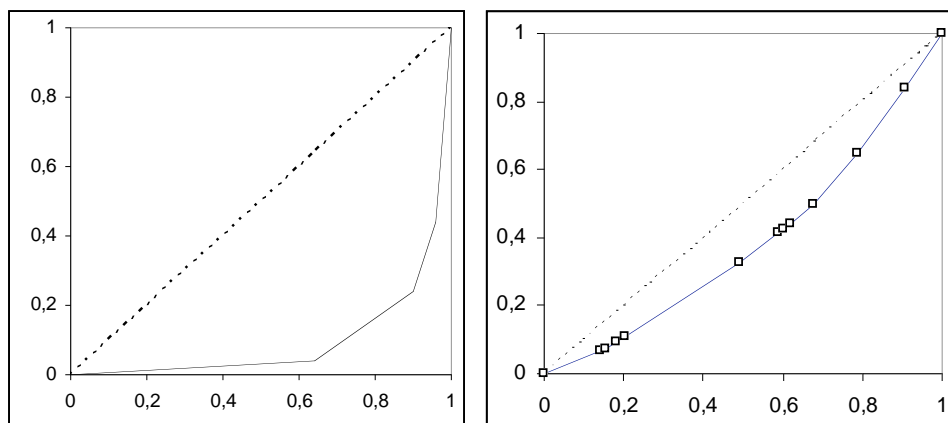
The value of concentration index “ $ar$ ” for the example from table 3 is equal to 0,247. It means that consumption profiles in the investigated countries are much differentiated. However, value of concentration index for number of cows in farms in Poland and in 15 countries of the European Union (EU-15)  $ar = 0,803$  means a great difference.

Another tool of grade correspondence analysis infrastructure employed for research purposes was the over-representation visualization (see also other visualization methods – Chen, 2002; Chen, 2004; Dzemyda, 2001). In most of practical applications non-negative data set in a table  $T_{m \times k}$  with “ $m$ ” rows and “ $k$ ” columns may be identified with a two-dimensional probability distribution table (each element of the table is divided by the sum of values of all elements given in the table). The graphic

Table 3. Annual consumption of food products in Poland and Italy in 2001

Food products	Annual consumption in 2001 (in kg per capita)		Consumption structures		
			Italy	Poland	ratios
	Italy	Poland	$p_i$	$q_i$	$q_i/p_i$
Pulses	5.5	2	0.56%	0.25%	0.44
Fruits	139.9	54.9	14.24%	6.77%	0.47
Vegetable oils	27.5	14.1	2.80%	1.74%	0.62
Fish	24.7	13.1	2.52%	1.61%	0.64
Vegetables	177.9	119.2	18.11%	14.69%	0.81
Stimulants	7.2	5	0.73%	0.62%	0.84
Milk	247.1	176.8	25.16%	21.79%	0.87
Meat	91.2	70.5	9.29%	8.69%	0.94
Animal fat	16.1	14	1.64%	1.73%	1.05
Eggs	12	11	1.22%	1.36%	1.11
Cereals	162.1	155.5	16.51%	19.16%	1.16
Sugar, honey	31.6	43.1	3.22%	5.31%	1.65
Potatoes	39.3	132.2	4.00%	16.29%	4.07
Total	982.1	811.4	100.00%	100.00%	

Source: own elaboration



Source: own elaboration

Figure 1. Concentration curves for data given in Tables 2, 3.

presentation of the probability table is a map. In order to create such a map, the unit-quarter is divided into  $mxk$  rectangles with sides  $p_i$  ( $i=1,\dots,m$ ) and  $q_j$  ( $j=1,\dots,k$ ), where  $p_i$  are row marginal probabilities and  $q_j$  are column marginal probabilities. For each of the rectangles there are computed  $h_{ij}=p_{ij}/(p_i \cdot q_j)$ , where  $p_{ij}$  are probabilities given in the  $i$ -th row and  $j$ -th column of the normalized matrix  $T_{mxk}$ . Such ratios define over-representation degrees for separate cells of table  $T_{mxk}$  in relation to this what would appear if the table was built in a case of independence of row and column characteristics (that is a case of uniform mass distribution). The map is created in such a way that assuming some thresholds some colors are given to  $h_{ij}$  values. In the paper the following visualization was taken into account: (0;2/3) – white color, (2/3; 0.98) – light gray, (0.98; 1.02) – gray, (1.02; 3/2) – dark gray, (3/2;  $+\infty$ ) – black. These colors are correspondent to: high under-representation, under-representation, uniformity, over-representation and high over-representation. In the presented researches the column characteristic is „country” and the row characteristic is “year”. Separate cells of the table  $T_{mxk}$  contain volume of milk production, consumption, internal use and export in a selected country. The map takes up a space of an unit-quarter. A column width means a percentage share of a single country in a hypothetic market of the European Union. A row width illustrates a percentage share of a given year in the investigated period. Separate colors show deviations from an uniform distribution of considered characteristics.

### 3. RESEARCH RESULTS

The analysis of milk balance (table 4) shows that both in the European Union and Poland there is the overproduction of milk reaching 9-10%. This brings about the

necessity to control production volume and to look for chances of managing surpluses (mostly by export).

Table 4. Milk balance in the European Union in 2003 (in million tons of milk equivalent)

Specification	EU-15	Poland
Production	126.3	11.5
Import	4.0	0.4
Export	14.9	1.4
Consumption	115.4	10.5
Self-sufficiency index (%)	110	109

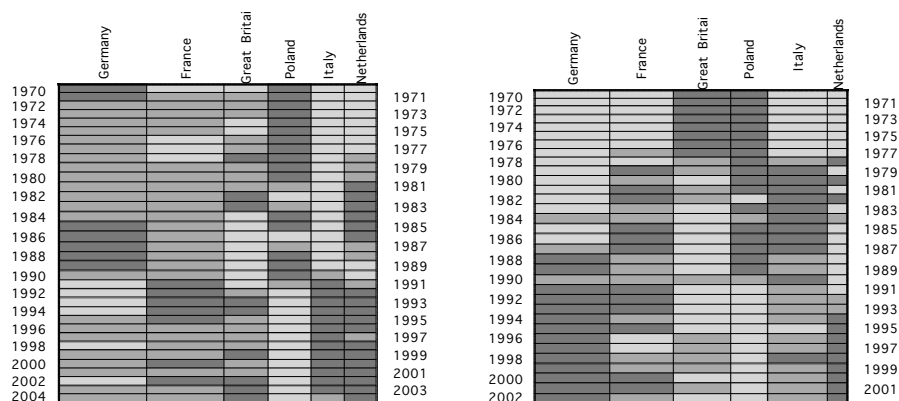
Source: Agrarbericht der Bundesregierung, Bonn 2004 and the Main Statistical Office, Poland

In the European Union milk production is quoted. Each country has strict production limits. The following limits for the years 2004/05-2007/08 were designated to Poland: the milk wholesale limit – 8.5 million tons; the milk direct sale limit – 0.5 million tons and the similar reserve quota. The European Union is planning to practice milk quoting up to 2014/15 although at first the years 2008/09 were considered. Milk production quotas for the new European Union members will not be increased, while quotas for 15 former members (EU-15) will be a little increased (the European Council's directive 1788/2003; Preserved Milk 227/2003).

Let's assume that milk production and distribution in 5 of 15 former European Union members and in Poland constitutes 100% of milk production on the hypothetical market. The analysis of shares of investigated countries in such defined market for the years 1970-2004 shows a really interesting phenomenon (see figures 2, 3).

Germany and France had the largest shares in milk production, while Netherlands and Italy reached the smallest shares (column width in figure 2). Analyzing figure 2 one can notice different behavior of milk producers having large shares in the hypothetical market and of those with small shares. Germany and France are characterized by uniform production distributions in the considered period (apart from some exceptions), but in such countries as Netherlands, Italy and Poland one can observe deviations from this uniformity. Before 1980 in Italy and Netherlands under-representation was visible and after 1980 – over-representation. In Poland there was observed the opposite phenomenon. The researches showed that before 1980 milk production for the hypothetical market in Poland was bigger then it came out from the general share. After 1980 this role was taken by such countries as Netherlands and Italy.

Different tendencies were observed in the case of milk consumption. First of all, shares of investigated countries in the market much changed. One can easy notice the increased share of Italy which is comparable to those of France and Great Britain. At the same time the share of Poland much decreased. Consumers' behavior on the market was different as well. In Germany and Netherlands in comparison to other countries increasing milk consumption was observed. In Italy, Great Britain and France

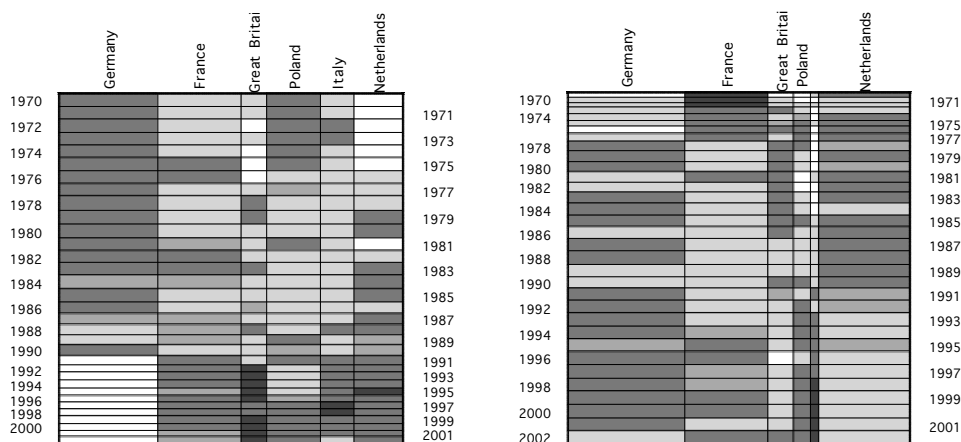


Figures 2, 3. Shares of investigated countries in milk production and consumption in the years 1970-2004

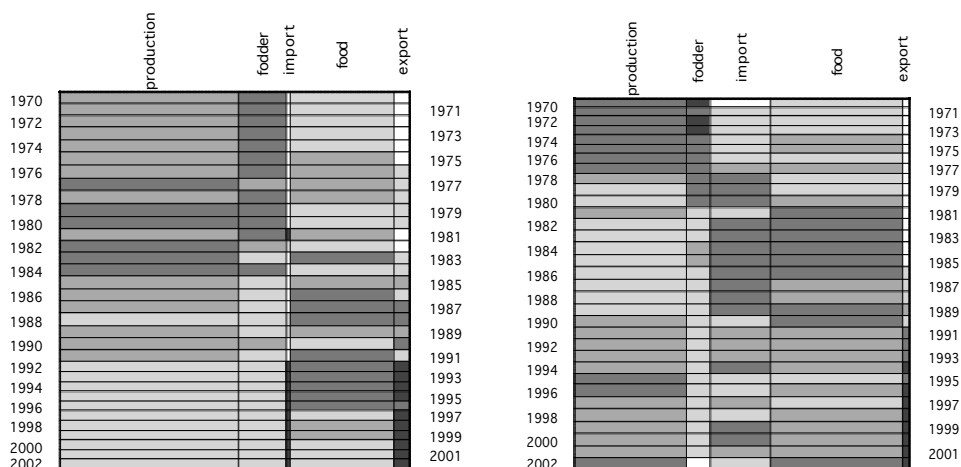
milk consumption levels were proportional to the market shares. Whereas in Poland after 1990 both milk production and consumption were proportionally lower.

Germany and France had the largest shares in milk use in farms while Great Britain and Italy had the smallest shares. In the considered period use of milk in farms became smaller and smaller on the contrary to the volume of export (see raw width in fig. 3, 4). Germany and Netherlands had the largest shares in export while the smallest shares were those of Italy and Poland. In the last few years in Great Britain spending milk on feeding was proportionally higher than in other countries. The opposite tendency was observed in Germany. In the last period Germany exported proportionally more than other countries. Different trends were noticed in Netherlands and Great Britain.

Some interesting conclusions may be drawn out from the comparison of milk production and distribution structures in Italy and Poland. In Poland the largest share in the hypothetical market fell to milk production while in Italy to milk consumption.



Figures 3, 4. Shares of investigated countries in internal use and export of milk in the years 1970 - 2002



Figures 5, 6. Visualization of milk supply and distribution in Italy and Poland from 1970 to 2002

Different relations were observed also in the considered period. In the last few years in Italy size of the considered market has been increasing, but in Poland it has been decreasing. In Poland a lot of milk was used for feeding purposes (much more than in Italy) and Polish import of milk was minimal in comparison to that of Italy. These differences probably result from consumers' habits. In Italy in comparison to Poland much more milk is consumed (see table 2 and figures 7, 8).

Both in Poland and in Italy shares of milk in consumption proportionally decreased, but the difference is still big: 250 liters per capita in Italy and only 170 liters per capita in Poland.

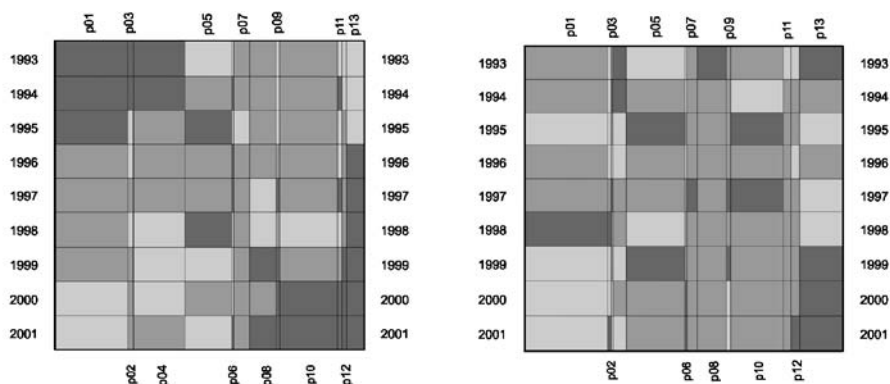
#### 4. CONCLUSIONS

In 2004 the European Union countries produced 143.3 million tons of milk. Then the overproduction of milk was equal to 9-10%. The main milk producers were such countries as Germany, France, Great Britain, Netherlands and Italy. These countries produced more than 70% of milk in the European Union. In the group of new members of the European Union the biggest milk producer is Poland.

Various tendencies were observed among investigated milk producers. Germany and France had the largest shares in the market of milk production while Netherlands and Italy had the smallest shares. However, considering the milk consumption market one could observe growing share of Italy comparable to those of France and Great Britain. The share of Poland was much smaller.

The largest shares of milk use in farms had such countries as Germany and France while the smallest belonged to the Great Britain and Italy. In the considered period use of milk in farms became smaller and smaller contrary to the export of milk. Com-





p01 –milk, p02-adiposes, p03-pulses, p04-potatos, p05-vegatables, p06-stimulants, p07-sugar&honey, p08-meat, p09-eggs, p10-cereals, p11-fish, p12- vegetable oils, p13-fruits

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Figures 7, 8. Visualization of average consumption profiles in Poland and Italy in the years 1993-2001

paring supply and distribution of milk one could state that Italy had larger share in the milk consumption market and smaller share in the milk production market. Moreover, in Poland much more milk was spent on feeding.

Consumption profiles in Poland and Italy are much different. Italian diet is the Mediterranean diet in which fish, vegetables and fruits are dominant while in the Polish diet potatoes, sugar and cereals dominate.

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